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Growth of Slash Pine Plantations on the George Walton Experimental Forest

by

Frank A. Bennett

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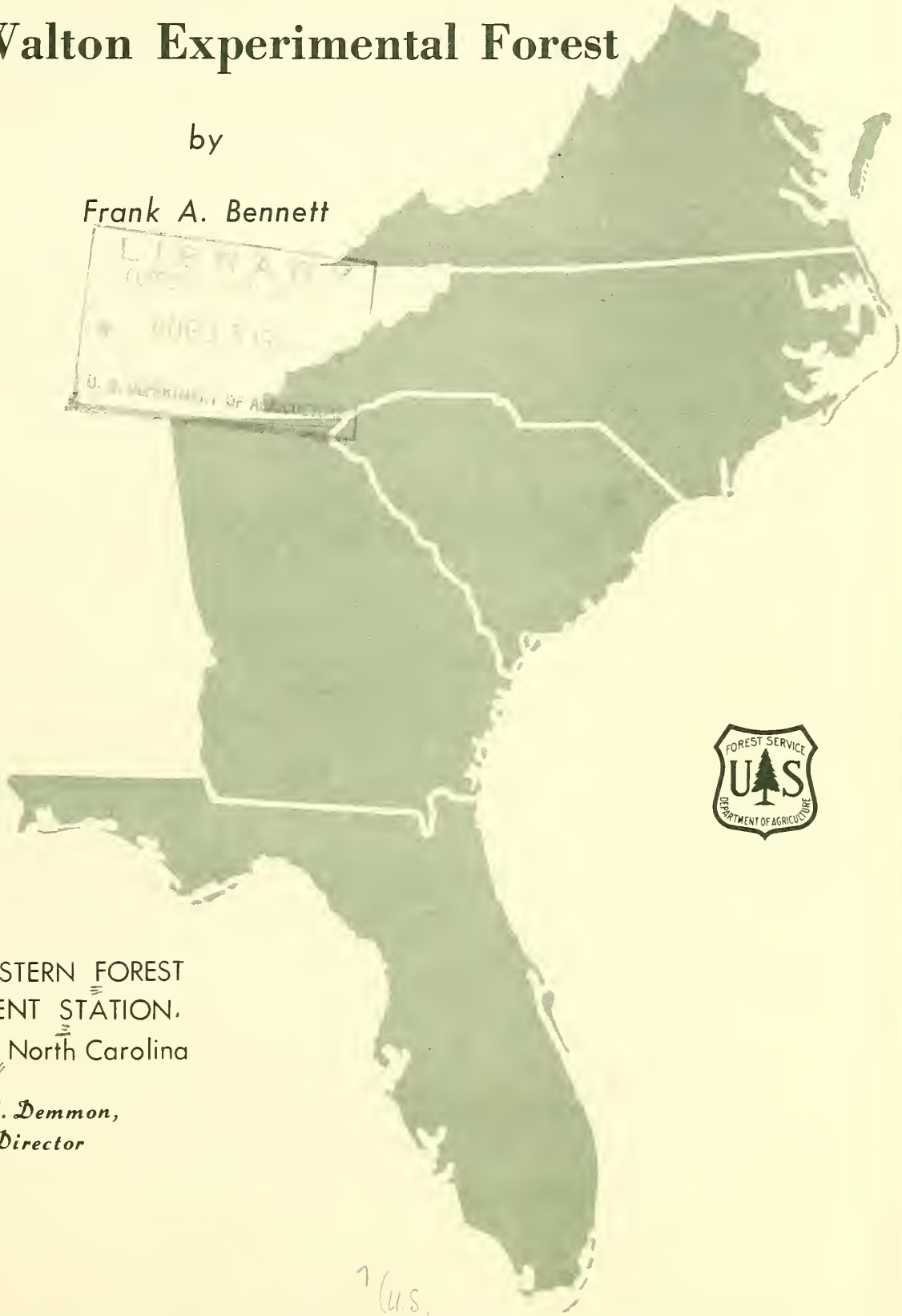

SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

E. L. Demmon, Director

U. S. DEPARTMENT OF AGRICULTURE—FOREST SERVICE

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GROWTH OF SLASH PINE PLANTATIONS ON THE GEORGE WALTON EXPERIMENTAL FOREST

by
Frank A. Bennett

INTRODUCTION

According to records of the Georgia Forestry Commission, about 625,000 acres have been planted to trees in Georgia since 1929. Of this total more than 75 percent has been planted to slash pine (Pinus elliottii Engelm.). Despite this great amount of planting, very few reports dealing with the development of slash pine plantations in Georgia are available. This paper is a report on the growth and yield of 21 slash pine plantations on the George Walton Experimental Forest, Dooly County, Georgia. It shows what may be expected of planted slash pine on upland coastal plain soils having a site index of 70 to 80 feet for natural stands.

Holt E. Walton of Cordele, Georgia, began acquiring marginal and submarginal farmlands in Dooly County in the mid-thirties, primarly for the purpose of gaining additional timber for his naval stores operation. After one or two unprofitable attempts at row-cropping the fields, he decided to plant them to slash pine. Twenty years later this program is still under way and more than 1200 acres of these fields have been planted.

The U. S. Forest Service has leased rent-free for 50 years 4200 acres of these lands for research purposes. Included in the area are 600 acres of Mr. Walton's plantings. Figure 1 outlines the forest and its plantations.

With one exception, all planting stock came from Georgia State nurseries. One shipment of seedlings came from Louisiana, but there is strong suspicion the seed were collected in north Florida and south Georgia. All planting was done with the planting bar. No site preparation was employed but most of the fields in the early years were cross-scored with a plow to indicate the desired spacing. In later years scoring has been in one direction only.

The spacing employed has varied from year to year. Emphasis at first was on naval stores and consequently all the older plantings are widely spaced--as few as 150 trees per acre. As pulp mills moved south and the market for pulpwood expanded, Mr. Walton reasoned that the wide spacings were not fully utilizing the growing space in the early years, and subsequent spacings were somewhat closer. The 1946 planting, for instance, was 6x8 feet, or 907 trees per acre. Most of the plantations of wider spacing are now of merchantable size and are the basis for this report. Plantings made since 1946 are not included.

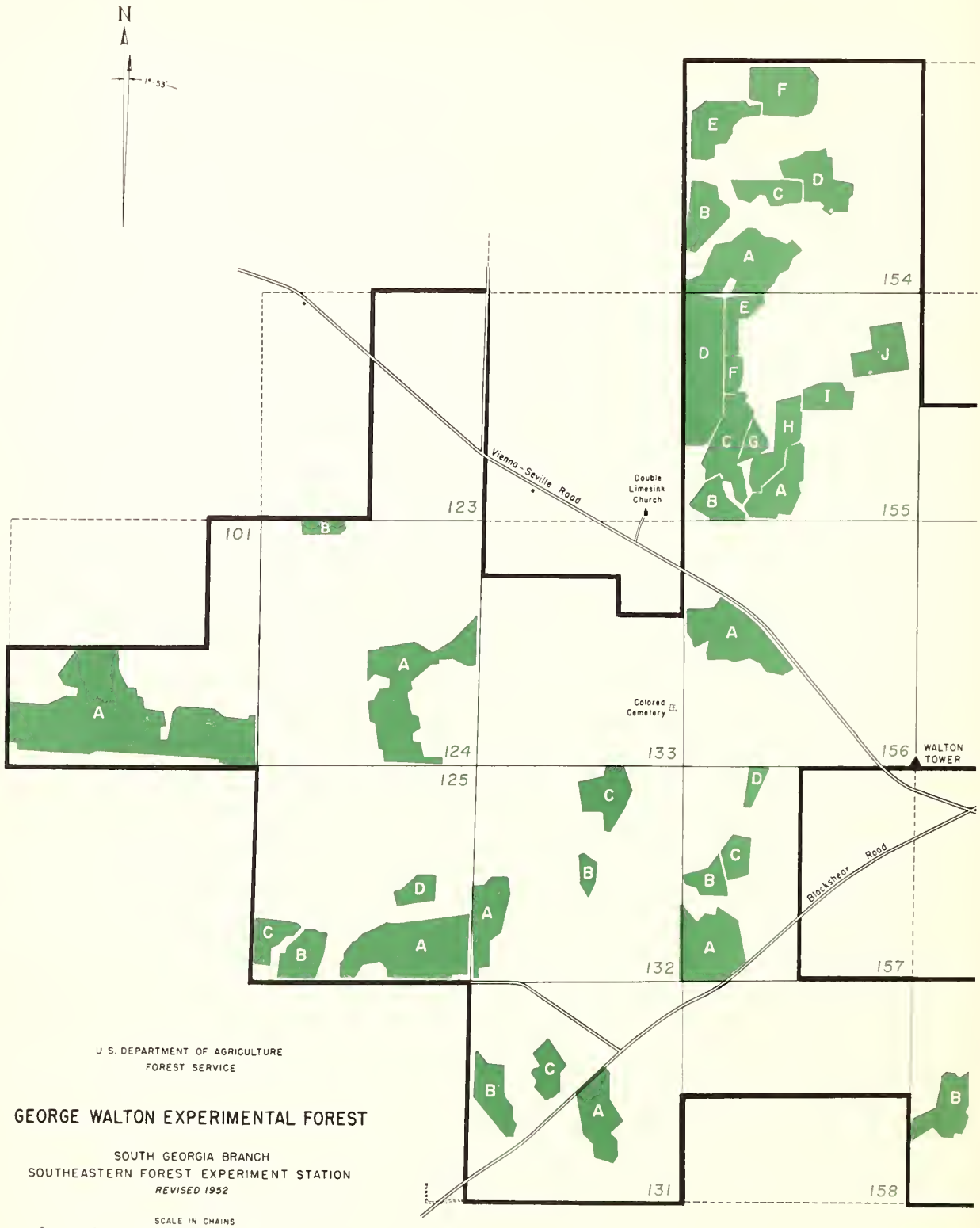
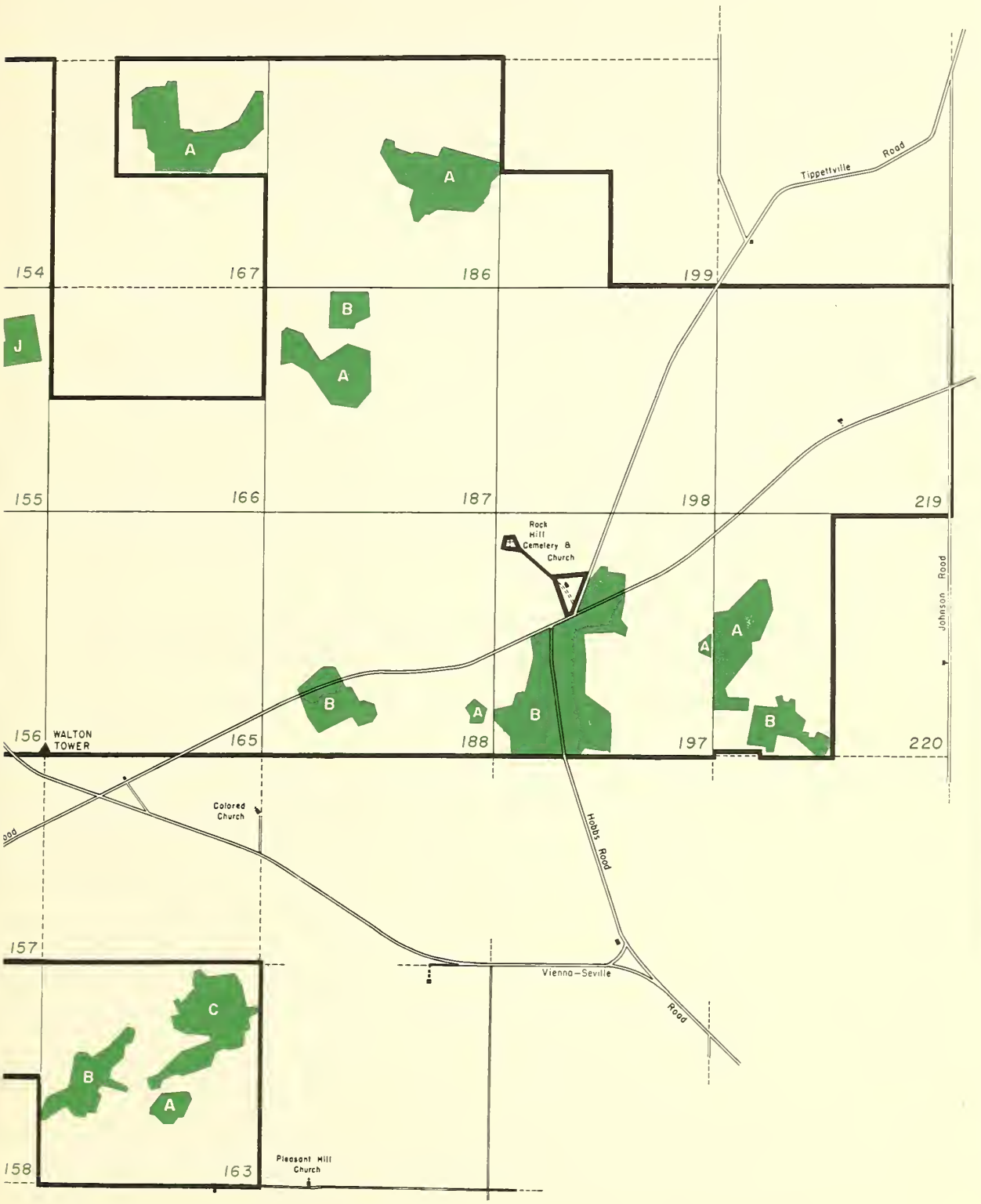


Figure 1.--Map of the George Walton Experimental Forest near Cordele, Georgia, showing location of the slash pine plantations.


154
167
186
199
155
166
187
198
219
156
WALTON TOWER
165
188
197
220
157
158
163
A
B
C
J
Rock Hill Cemetery & Church
Colored Church
Pleasant Hill Church
Tippettville Road
Johnson Road
Hobbs Road
Vienna-Seville Road

Although Walton made a strong effort to protect his holdings from wildfire, he was in a county without organized fire protection, and several of the plantations included in this report were severely burned once or more. Most of these burns occurred during the war years while Walton was in the armed forces and labor was scarce. Since the organization of the experimental forest, only 6 plantations out of the 47 shown on the map have burned; two of these were partial burns. Early in 1954, Dooly County organized a fire protection unit under state supervision and has aided greatly in protecting the experimental area.

SOILS AND CLIMATE

The Walton plantings are on soils typical of the middle coastal plain. For the most part they are loamy sands over a friable sandy clay subsoil. Drainage on most areas is good to excessive, with some minor areas having poor drainage. Better than 98 percent of the acreage in these plantations is represented in four soil series. Table 1 lists for the experimental forest the various soil series, the percentage of plantation acreage in each, and the site index for natural slash pine stands on each series. The site indexes ranged from 69 to 80 feet, averaging about 75 feet. Most of the stands from which these site indexes were derived originated in old fields. Thus, the growing conditions of the natural stands are quite similar to those for plantations growing on the same series. A detailed description of the soils is given in the appendix.

Table 1.--Summary of growth and survival by soil type and spacing for slash pine plantations on the George Walton Experimental Forest

Soil type	Site index 1/	Average spacing	Plantations	Area		Survival	Annual yield
	Feet	Feet	Number	Acres	Percent	Percent	Cords
Gilead loamy sand	80	15x16	9	219	63.2	78	1.22
Lakeland loamy sand	76	15x15	4	69	19.9	80	1.31
Cuthbert sandy loam	70	12x12	5	31	8.9	72	1.19
Susquehanna loamy sand	69	15x15	2	23	6.6	69	1.01
Mayhew sandy loam	(2/)	15x15	1	5	1.4	64	0.91

1/ Site index in this table refers to the height dominant and codominant slash pine have attained in natural stands at 50 years of age on a specific soil type on the George Walton Experimental Forest.

2/ Site index not available.

Rainfall on the experimental forest has averaged 48.26 inches annually for the past 7 years. The record by months and years is presented in table 2. There is wide variation in both the monthly and the annual precipitation. By months, it ranged from a minimum of 0.24 inch in October 1951 to a maximum of 10.50 inches in December 1953. By years, precipitation ranged from a low of 26.84 inches in 1954 to a high of 62.89 in 1953. The driest months are October and November. Rain is ordinarily well distributed among the remaining months.

Table 2.--Yearly and monthly rainfall from 1948 through 1954 on the George Walton Experimental Forest

Month	1948	1949	1950	1951	1952	1953	1954	Mean
	Inches							
January	5.34	2.74	1.68	0.93	2.29	4.43	0.98	2.63
February	4.25	5.52	2.16	1.18	6.57	6.01	1.19	3.84
March	8.36	3.23	5.78	5.46	7.87	4.31	2.85	5.55
April	5.22	4.15	1.73	2.76	2.94	5.09	1.38	3.32
May	2.88	2.90	7.56	1.42	4.69	5.20	4.22	4.12
June	2.69	7.14	3.89	3.58	3.18	3.81	1.36	3.66
July	8.08	9.20	4.79	9.43	0.73	6.42	3.86	6.07
August	3.92	8.08	1.98	3.74	5.33	4.29	3.20	4.36
September	2.08	2.60	4.39	5.87	7.51	10.12	1.37	4.85
October	6.65	1.87	4.35	0.24	0.86	1.48	1.37	2.40
November	5.72	0.65	0.95	4.28	1.47	1.23	2.71	2.43
December	6.66	0.84	5.92	4.55	5.28	10.50	2.35	5.16
Totals	61.85	48.92	45.18	43.44	48.72	62.89	26.84	
Mean	5.15	4.08	3.76	3.62	4.06	5.24	2.23	
						Yearly Mean		48.26
						Monthly Mean		4.02

In general, the climate is mild with a long growing season. The United States Weather Bureau reports the following dates for killing frosts for Dooly County, Georgia, and vicinity:

Average date of first killing frost	November 10
Average date of last killing frost	March 20
Length of growing season	235 days
Record early date of killing frost	October 11
Record late date of killing frost	April 26

GROWTH AND DEVELOPMENT

Detailed data on growth and development of the various plantations are recorded in table 8 in the appendix. No attempt at a formal analysis has been made because of the difficulty of reconciling the many influences affecting growth of the trees. Histories are given as completely as possible. All averages are based on 100-percent inventories, with the exception of height data, which are based on a random 10-percent sample.

At 11 years of age and over, survival ranged from 42 to 88 percent. The average was 74 percent. The low of 42 percent occurred in a plantation that was severely burned in May of its ninth growing season. Heavy mortality occurred at that time.

An interesting point is the survival of all plantations by soil series classes. This is shown in table 1 (the plantation with a 42-percent survival is not included). Survival figures are arranged in almost the same order as the site indexes of the various soils, and for each soil survival is almost the same figure as the site index.

Annual yields per acre at 11 years of age and over (table 8) ranged from 0.77 to 1.46 cords. The low yield occurred in a 16x17-foot spacing with a survival of 65 percent. This plantation was burned several times. The high yield of 1.46 cords occurred in two plantations--one spaced 11x11 and one spaced 17x17 feet. As far as we know,neither plantation ever burned. As expected, the yields of these plantations tend to parallel the productivity of the soil types, as indicated by their site index for natural stands of slash pine (table 1).

Table 3 gives the annual cordwood and basal area growth for the various spacings. There appears to be no real pattern of growth as related to spacing. Factors other than spacing have greatly influenced growth, and the data are not adequate for a regression analysis which might sort out the influence of each factor.

As table 8 shows, the 8x8 spacing suffered severe burns and numerous wildlings helped maintain the per-acre yield despite very poor survival. The 10x10, 11x11, and 17x17 spacings were never burned, have good survival, and have comparable yields. Two-thirds of the 15x15 and 16x16 spacings, on the other hand, suffered one or more severe burns and are below the other three spacings in average yields. As illustrated in table 8, when history and site are

Table 3.--Survival and growth in basal area and cordwood volume for slash pine planted at various spacings. Includes only plantations over 10 years of age

Spacing (feet)	Survival	Annual growth per acre	
		Volume	Basal area
	Percent	Cords	Square feet
8x8	42	0.95	4.28
10x10	72	1.34	5.65
11x11	84	1.46	5.72
15x15 1/	77	1.20	4.10
16x16 2/	78	1.10	3.77
17x17	(3/)	1.46	5.14

1/ Includes 15x16 spacings.
2/ Includes 16x17 spacings.
3/ No figure available, but survival is good.

Figure 2.--A plantation compartment clearcut at 19 years of age. This study contains 16 compartments designed to contrast returns from four rotations--19, 25, 35, and 50 years. The above compartment yielded 26.3 cords per acre mill scale, or an average of 1.38 cords per acre per year. The trees in the background are a portion of the same plantation.

similar the difference in growth between spacings is not pronounced. Figure 2 shows a plantation compartment with a 15x15 spacing, which was clear cut at 19 years of age. The annual yield, as scaled at the pulp mill yard, was 1.4 cords per acre.

Averaging all ages and spacings, basal area growth has been 3.90 square feet per acre per year. At age 11 and over, the average has been 4.78 square feet. The most rapid growth was 7.54 square feet in an 8-year-old plantation with a 6x8 spacing. The total at this age for this plantation was 60.33 square feet per acre, while the average diameter was 4.0 inches. Based on the present survival figure of 71 percent, total basal area per acre will be about 126 square feet when the average d.b.h. is 6 inches. Although this figure is well beyond the generally accepted point for release, it is obvious a thinning for pulpwood could not be accomplished earlier. Even a cut when the average diameter is 6 inches will present a problem, since analysis of eight plantations with an average diameter of 6.1 inches revealed that 16 percent of the trees were under the minimum merchantable size of 5 inches. Thus, if mechanical or alternate-row thinning is employed, one-sixth of the trees cut will be below 4.6 inches d.b.h. If a selective type of thinning is undertaken, the cut will have to be concentrated in the larger and thriftier stock.

If thinning is delayed until the average diameter is 6.5 inches--which would mean a basal area per acre of 148 square feet--we will still have to cope with the problem of undersize trees. In the wider spacings the first thinning presents no such problem, as figure 3 illustrates.

Figure 3.--Thinning a 19-year-old plantation compartment. Approximately one-fourth of the basal area and one-fourth of the volume was removed.

Annual diameter growth ranges from 0.40 to 0.73 inch for all ages and spacings. The average is 0.53 inch. Figure 4 shows sizes at various ages. Reference to table 8 will show that the closer spacings are not well represented in the older age classes, but that the wider spacings are well represented in the younger ages. As expected, diameter growth bears a direct relationship to spacing--the wider the spacing the greater the diameter growth (fig. 5). In relating diameter growth to spacing, the reader should remember that fire history favors the 10x10 and 11x11 spacings, since there is no record of these plantings ever having burned. On the other hand, a part of the plantings in each of the other three spacings have burned over one or more times.

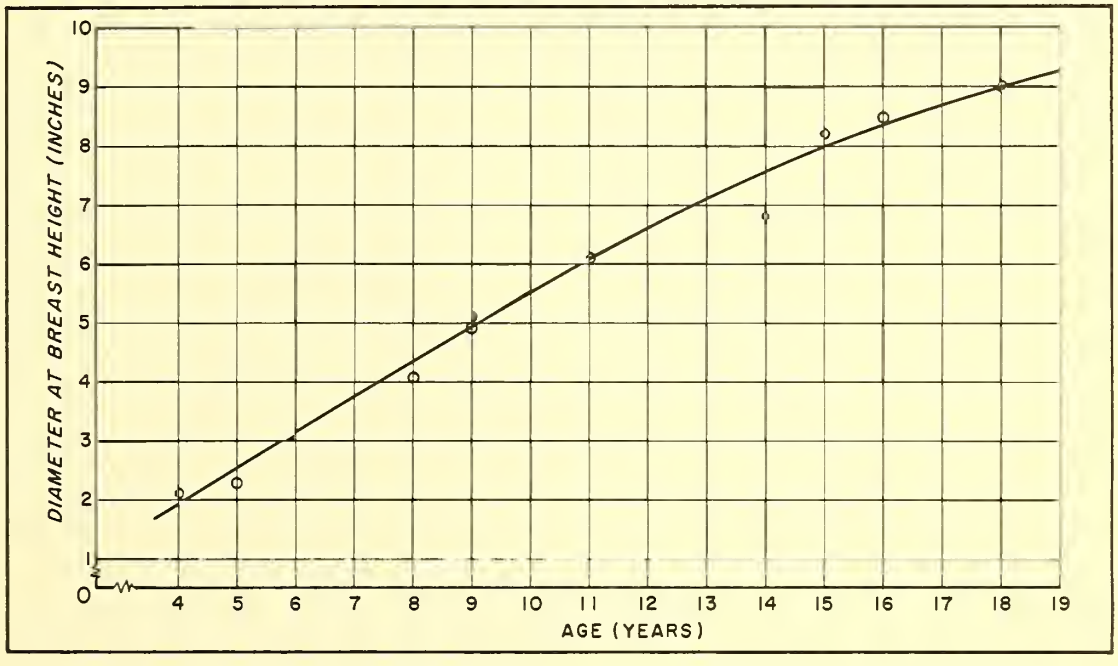


Figure 4.--Diameter of planted slash pine related to age for all soils and spacings.

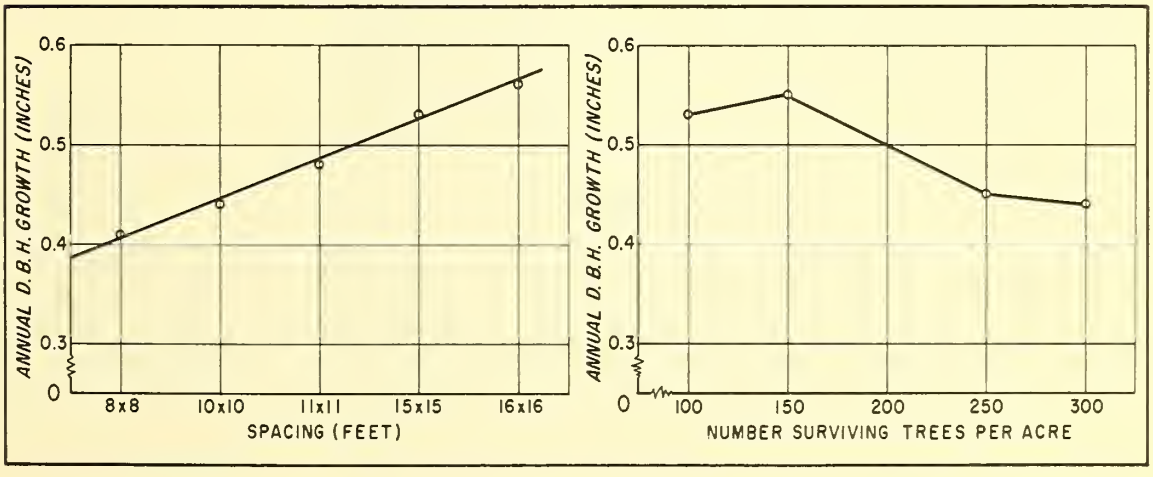


Figure 5.--Annual d.b.h. growth of planted slash pine in relation to spacing and number of surviving trees per acre at age 14 and over.

The distribution by diameter classes for the various spacings is a point of interest. The curves of figure 6 show that this distribution has a characteristic bell shape. Curves for the wider spacings, however, have much longer tails than do the closer ones. This is to be expected since the average diameter is considerably larger in the wide spacings. Figure 7 illustrates the unusual diameter growth made by a planted slash pine in a 15x15 spacing.

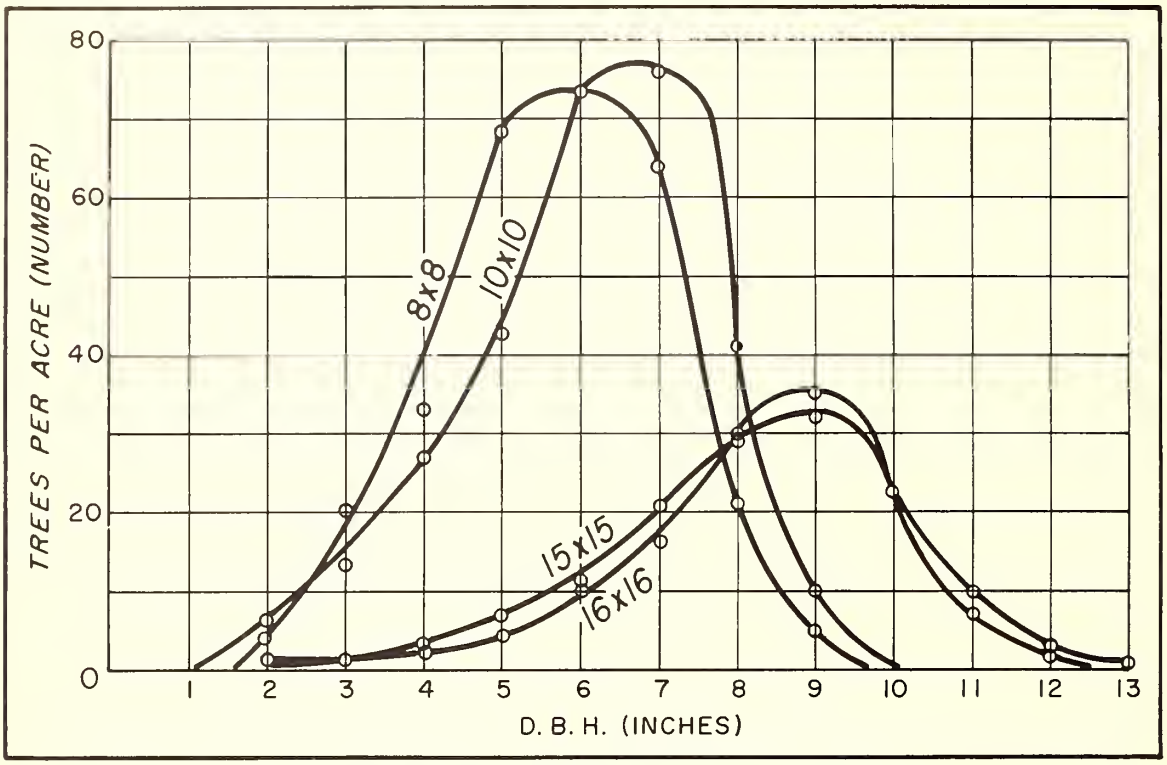


Figure 6.--Frequency distribution of diameters of planted slash pine for various spacings at age 14 and over. Each curve represents several plantations.

Figure 7.--Holt E. Walton, owner of the George Walton Experimental Forest and cooperator with the U. S. Forest Service in forest management research, calipering a 12-inch tree he planted 13 years before.

Height growth has averaged 2.85 feet annually. The range is from a low of 2.00 feet to a high of 3.87 feet. There seems to be no relation between spacing and height growth; table 4 illustrates this along with the relation to site index. It is interesting to note that the lowest average height growth of planted trees occurred on the soil with the lowest site index for natural stands, reflecting the reliability of these soil-type site indexes. Comparative photographs in figure 8 illustrate the rapid growth of field-planted slash pine.

Table 4.--Mean annual height growth of planted slash pine at 14 years of age and over for various spacings and by site index

Spacing (feet)	Plantations	Average soil site index [1/]	Mean annual height growth
	Number	Feet	Feet
8x8	1	80	2.9
10x10	2	77	3.0
11x11	1	70	2.6
15x15	6	78	3.0
16x16	3	78	3.0
17x17	1	78	3.3

1/ Average site index for natural slash pine associated with the soils on which each spacing occurs.

Figure 8.--Repeat photographs illustrating the rapid growth of planted slash pine. Dates of photos are: (left) October 28, 1949; (right) December 12, 1952. The trees were planted during the 1942-1943 planting season and are spaced 12x12 feet. At 11 years of age the plantation had an average of 15.64 cords per acre, which is an average yield of 1.42 cords per acre per year.

SAWTIMBER VOLUMES

In general board-foot production in these young plantations varies with spacing. The closer spacings produce little sawtimber volume by age 15 in comparison with the wider ones. Although the narrow spacings are not represented in the sawtimber age classes except by one small planting, it is apparent they would not measure up to the wider spacings in board-foot production, because the medium spacings fall far short in this respect. Sawtimber volumes for the various spacings appear in table 5.

The 8x8 spacing shows an average of 467 board-feet per acre at 14 years of age, but only 55 feet of this are in planted trees, distributed among only two sawtimber trees per acre. The other 412 board-feet occur in wildlings, as the large average diameter indicates.

Table 5.--Survival, average d.b.h., and board-foot volume production for slash pine plantations of various ages and spacings

Plantation number	Spacing	Age	Survival	Sawtimber stand per acre				Average size of sawtimber trees	
				Trees	Volume			D.b.h.	Volume
					Planted trees	Wild trees	Total		
	Feet	Years	Percent	Number	Bd. ft.	Bd. ft.	Bd. ft.	Inches	Bd.ft.
132B	8x8	14	42	8	55	412	467	11.0	58
155A	10x10	14	70	13	74	709	783	11.5	59
155E	10x10	14	63	16	65	765	830	11.5	53
155G	11x11	14	84	11	254	69	323	9.2	28
101A	15x15	15	83	60	--	--	1888	9.9	31
132A	15x15	15	78	73	2504	304	2808	10.0	38
132C	15x15	15	--	62	1778	682	2460	9.9	40
163A	15x15	15	64	39	997	726	1723	10.2	44
163B	15x15	15	85	55	1876	414	2290	10.1	42
188B	15x15	15	66	42	1257	433	1690	10.3	40
101A	15x15	16	83	86	3186	122	3308	10.0	38
186A	15x15	18	75	69	3047	68	3115	10.3	45
124A	16x16	14	81	46	--	--	1481	10.0	32
124A	16x16	15	81	60	1899	176	2075	10.0	34
155I	16x16	15	86	52	1623	159	1782	10.0	34
155J	16x16	15	70	31	938	62	1000	9.9	32
163C	16x16	15	86	44	1527	133	1660	10.0	38
167A	16x16	15	65	24	737	86	823	10.1	35
220A	17x17	15	--	77	2716	51	2767	10.2	36

Figure 9.--A plus tree in one of the George Walton Plantations which has been labeled, described, and set apart for possible use in establishing seed orchards and other genetical work.

The same situation holds for the 10x10 spacing. In plantation 155A, for example, only 74 board-feet out of 783 are found in planted trees at 14 years of age. Three planted and 10 wildling trees per acre were classed as sawtimber. At 14 years of age in the 11x11 spacing, only 10 planted trees per acre, with a volume of 254 feet, were of sawtimber size and quality. On the other hand, the 15x15 spacing at 15 years of age has an average of 2265 board-feet per acre, only 375 of which are in wildlings. There is an average of 50 planted and 7 wildling sawtimber trees per acre. The 16x16 spacings have an average of 1456 feet per acre, 111 of which are in wildlings. There is an average of 39 planted and 3 wildling sawtimber trees per acre. In the 17x17 spacing the averages jump to 2676 board-feet and 75 trees per acre at 15 years of age. Although in the latter case no distinction can be made between planted and wild stock, it is known that the number of wildling sawtimber trees is negligible.

It is recognized, of course, that the more numerous wildlings in the closer spacings inhibited diameter growth to a certain extent. It is extremely doubtful, however, that the big differences in sawtimber volumes between spacings can be primarily attributed to the influence of the volunteers.

There is wide variation of sawtimber volumes within spacings. On some areas the reason for this variation is survival. On other areas where survival differences are minor, variations may be attributed to form and quality. Some plantations have more mechanical defects and are more disease-ridden than others (see section on disease and defect). Pictured in figure 9 is the type of tree that forest managers desire.

The data from these plantations illustrate the surge of "ingrowth" that occurs when the trees first reach sawtimber size. For example, plantation 101A jumped from 1888 board-feet at $14\frac{1}{2}$ years of age to 3308 at 16 years, and the number of sawtimber trees increased from 60 to 86. The tremendous board-foot growth possible in slash pine plantations is illustrated in figure 10.

The period of transformation from pulpwood to sawtimber size is a time of rapid increase in values. If an owner is operating on a short rotation, he should be on the alert and not make the mistake of liquidating prior to or during this period.

Figure 10.--A 19-year-old slash pine plantation spaced 15x15 feet. The average diameter was about 10 inches at this age, and there was a total of 7,500 board-feet of sawtimber per acre. Stumps in the foreground are from the initial thinning, which removed about 6 cords per acre.

EFFECT OF INTERPLANTING

In 1945 Mr. Walton, as usual, planted several old fields to slash pine. Thinking in terms of naval stores production, he used a spacing of approximately 15x15. A year later he reasoned that from the standpoint of pulpwood production the spacing was possibly too wide to fully utilize the growing space. To rectify this, he interplanted in one direction, assuming the one year's advantage of the first planting would have little effect on his interplants. The one year's advantage, however, has proved to have a decided effect. The interplants were so suppressed that the interplanting was a waste of money. Table 6 and figure 11 illustrate this clearly. These results have been reported in detail in "Reduction in Growth of Interplanted Slash Pine," Southeastern Forest Experiment Station Research Note Number 55, and "Interplanted Slash Pine Fails," Southern Lumberman, December 1954.

One identifiable example of replanting is found in the plantations on the experimental forest. Although this replanting was accomplished 3 years after the original planting, the results are worthy of note. An area of 5.72 acres was planted in 1942 at approximately a 10x10 spacing. Survival was low and the misses were replanted in 1945. The plantation was inventoried in 1954 when the first planting was 13 years old. The average diameter of the original planting was 6.4 inches; that of the replants 2.4 inches. Average heights were 40 and 20 feet respectively. Survival of the replants is about 35 percent. It appears certain that very few, if any, of the replants will reach merchantable size.

Table 6.--Average diameters and heights of six interplanted slash pine plantations. The second planting was made 1 year after the first

Plantation	Area	Average d.b.h. [1]		Average height [2]	
		1st planting	Interplants	1st planting	Interplants
	Acres	Inches	Inches	Feet	Feet
155C	12.15	4.7	3.5	33	24
155H	8.76	5.1	2.6	33	22
157A	15.53	4.9	3.0	32	22
157B	4.14	4.5	3.4	32	24
157C	4.09	5.0	3.5	32	20
157D	1.98	4.2	2.8	29	22
Mean		4.7	3.1	32	22

1/ 9 years after the interplanting.
2/ 10 years after the interplanting.

Figure 11.--The small trees in the center row are interplants set out 1 year after the original planting. They are rapidly being suppressed. The same suppression of interplants has occurred in six different plantations covering a range of four soil types. Plantations established from the same lot of stock that was used for the interplanting are making average growth or better.

FUSIFORM RUST INCIDENCE AND MECHANICAL DEFECT

Inventory records show that an average of 5.2 percent of the trees in the plantations listed in this report are infected with fusiform rust (Cronartium fusiforme). The degree of infection ranges from a low of 1.0 percent to a high of 16.3 percent. These figures include both limb and trunk infections, but limb cankers were not recorded unless the disease appeared likely to enter the trunk.

Table 7 illustrates the degree of infection and the percentage of forking for the various spacings. There is only slight evidence of a relationship between spacing and the degree of rust infection. Perhaps a larger sample might establish such a relationship.

Forking was the only mechanical defect recorded. An average of 1.7 percent of the trees have this defect, with a range among plantations of 0.3 percent to 5.0 percent. Forking tends to increase with spacing.

Table 7.--Percentage of planted slash pine with fusiform rust infection and forked stems

Spacing (feet)	Plantations	Rust infection	Forked trees
	Number	Percent	Percent
6x8	3	7.1	0.7
8x8	1	2.0	0.5
10x10	3	3.5	0.9
11x11	1	3.7	1.0
15x15	7	7.6	2.7
16x16	5	2.3	2.0
17x17	1	8.0	5.0

EARLY GROWTH OF PLANTED SLASH PINE

Measurements have been made for each of 3 years on the growth of field-planted slash to show the pattern in the early years (figures 12 and 13).

Height growth averaged about 0.5 foot the first year, 1.9 feet the second, and 2.9 feet the third. The third year's growth is about the average that all old-field plantings on the experimental forest have made throughout their life. Apparently it takes about 3 years for slash pine to get established and attain its level of average growth.

The time of year at which growth occurs is another point of interest. Growth by months for the year 1954 is outlined in figure 12. Approximately 60 percent of the growth was completed by April 30, and 77 percent by May 31. On these same dates in 1953, the percent of growth completed was about 55 and 68 percent respectively. In 1953 about 20 percent of the growth occurred after June 30. In 1954 about 10 percent came after this date.

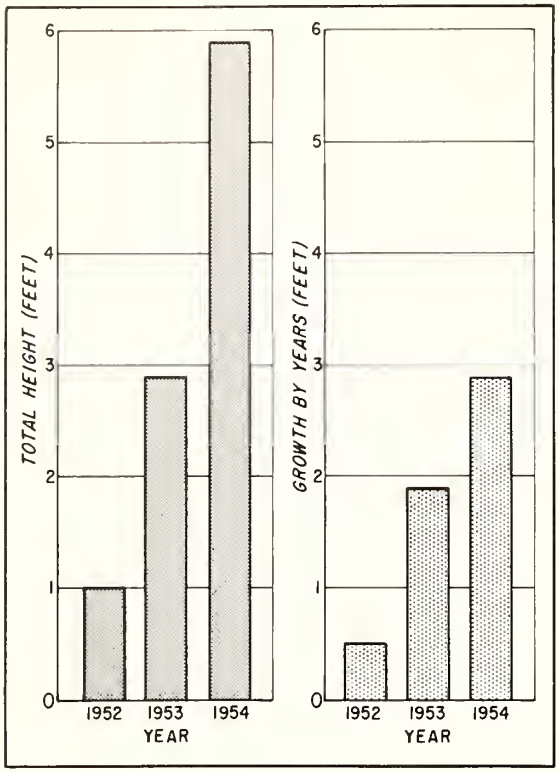


Figure 12.--Height growth of field-planted slash pine during the first 3 years after planting.

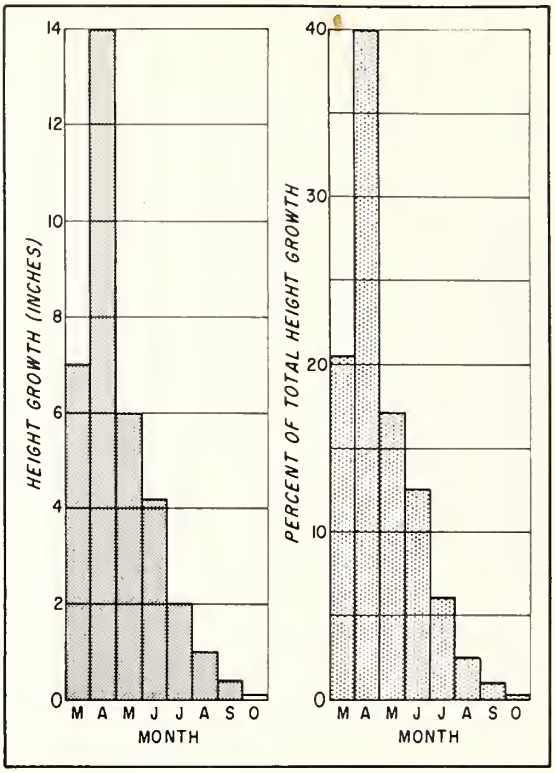


Figure 13.--Monthly height growth of field-planted slash pine during the third growing season.

OLD-FIELD VERSUS WILD-AREA GROWTH OF PLANTED SLASH PINE

In the winter of 1951-1952 two adjoining areas were planted to slash pine. One site was a field, the other a natural area supporting a very sparse stand of turpentined trees. The difference in growth between the two areas has become so apparent that a recent check was made. At the end of three growing seasons 100 sample trees from each area compared as follows:

Site	Average height (Feet)
Field	5.6
Wild area	2.6

Although the areas from which these data were gathered adjoin, the difference in growth between the two sites is not restricted to this particular location. All comparisons show that growth of field plantings has far surpassed that of plantings in wild or natural areas on the experimental forest. Figure 14 illustrates the difference in growth between the two sites.

Figure 14.--The above pictures, taken less than 100 yards apart, illustrate the difference in growth between cutover areas (left) and old-field sites (right). The pictures were made at the end of the third growing season.

SUMMARY

Summary data from 21 slash pine plantations on 70- to 80-foot sites, George Walton Experimental Forest, Dooly County, Georgia, show the annual diameter growth to average 0.53 inch up to 18 years, the annual height growth to average 2.9 feet, and the annual cordwood growth to average 1.2 cords. Diameter growth varies directly with spacing, and yield correlates closely with survival and site index. If fire history and site are similar, the difference in cordwood growth between spacings is not pronounced. Different spacings, however, resulted in highly significant differences in early production of board-foot volume. Only the wider spacings produced appreciable sawtimber volume by 15 years of age.

Fusiform rust infection bore only slight relationship to spacing. On the other hand, forking appears to increase with spacing. Observations further show that slash pine interplanted one year after the original planting is subject to early suppression, and that attempts to reinforce stands of 175 trees or more per acre are likely to meet with little success. The big difference in early height growth between trees on old-field and cutover areas is demonstrated.

APPENDIX

The following soils descriptions are taken from the descriptions submitted by the Soils Correlation Committee of the Bureau of Plant Industry, Soils and Agricultural Engineering, Knoxville, Tennessee. Mr. A. H. Hasty of this committee made the field survey.

Cuthbert Sandy Loam

Surface soil: 4 to 16 inches deep gray to dark grayish-brown, friable sandy loam; moderate organic content. Quartz gravel up to 5 inches in diameter found in local areas.

Subsoil: Yellowish-red to yellowish-brown, firm to friable sandy clay loam.

Drainage: Surface runoff medium to high, internal drainage medium to slow.

Gilead Loamy Sand

Surface soil: 10 to 18 inches deep in most phases, although it may range from 18 to 30 inches in the thick phases; very dark-grayish brown to olive brown, loose loamy sand with small organic content in upper level.

Subsoil: Yellowish-brown to reddish-yellow firm sandy clay that becomes plastic when wet. Strong mottling between 26 and 42 inches.

Drainage: Surface runoff medium to rapid, depending upon slope; internal drainage rapid in upper level but moderate to slow in lower.

Lakeland Loamy Sand

Surface soil: 30 to 40 inches deep; grayish-brown to yellow, loose loamy sand. Small amount of organic matter in first 6 inches.

Subsoil: Yellow mottled with strong brown, light gray, and red firm to very firm sandy clay.

Drainage: Surface runoff usually high; internal drainage rapid.

Mayhew Sandy Loam

Surface soil: Very dark-gray friable sandy loam with a fairly high organic content.

Subsoil: Grayish-brown to light-gray firm to very firm sandy clay mottled with strong brown, reddish-yellow, and pale olive. Part of the material has appearance at lower levels of low-grade Fuller's earth.

Drainage: Surface runoff low; internal drainage slow.

Susquehanna Loamy Sand

Surface soil: 3 to 16 inches deep dark grayish-brown loose loamy sand to sandy loam with small organic content.

Subsoil: Light yellowish-brown to red clay mottled with red, light-gray, reddish-yellow, and pinkish-gray. Very plastic when wet. At 42 inches the material becomes more purplish and gray.

Drainage: Surface runoff medium to high; internal drainage slow to very slow.

Table 8.--Growth and survival of individual slash pine plantations by spacing, soil type, and age

Plantation number	Spacing	Soil	Site index	Age	Area	Trees planted per acre	Survival	Average d.b.h. 1/	Maximum height 1/	Average height 1/	Mean annual growth per acre 2/	Basal area per acre 2/
	Feet	Type	Feet	Years	Acres	Number	Percent	Inches	Feet	Feet	Cords	Square Feet
187A	6x8	Gilead loamy sand	80	5	15.06	907	(3/)	2.2	17	11	--	11.013
187B	6x8	Gilead loamy sand	4/ 80	5	5.31		(3/)	2.1	18	12	--	22.383
131A	6x8	Cuthbert sandy loam	4/ 70 (80)	5 8	9.03		(3/) 71	2.4 4.0	19 34	12 26	-- 0.55	22.970 60.331
132B	8x8	Gilead loamy sand	80 (65)	6 14	2.36	680	(3/) 5/ 42	2/ 2.5 5.7	18 49	13 41	6/ 0.56 0.95	24.864 59.910
155A	10x10	Cuthbert sandy loam	70 (68)	8 14	8.81	436	73 70	3.2 6.0	24 48	17 40	6/ 0.26 1.31	26.671 75.423
155E	10x10	Gilead loamy sand	80 (68)	8 14	4.19		64 63	3.5 6.2	26 47	18 39	6/ 0.78 1.31	29.151 73.724
155D	10x10	Lakeland loamy sand	76 (73)	4 11	21.81		78 75	2.1 6.1	16 43	11 35	-- 1.42	9.250 69.304
155G	11x11	Cuthbert sandy loam	70 (68)	8 14	2.68	360	85 84	3.4 6.7	24 47	17 37	0.09 1.46	21.919 80.038
132A	15x15	Lakeland and Gilead loamy sands	76 (73)	7 15	9.23	194	(7/) 78	2/ 5.1 8.5	34 58	24 47	0.58 1.31	23.647 67.329
132C	15x15	Gilead loamy sand	80 (75)	7 15	7.72		91 85	4.7 7.8	34 56	25 49	0.77 1.38	5/ 30.753 5/ 73.811
163A	15x15	Mayhew loamy sand	-- (71)	9 15	3.88		67 64	4.4 7.3	36 56	23 41	0.36 0.91	5/ 19.612 5/ 49.100
188B	15x15	Susquehanna and Cuthbert loamy sands	69 70	9 16	11.48		(7/) 66	2/ 4.5 8.1	32 55	26 45	0.23 1.01	15.576 56.667
186A	15x15	Gilead loamy sand	80 (68)	10 18	22.28		(7/) 75	2/ 5.2 9.0	38 60	24 48	0.50 1.15	5/ 25.748 8/ 69.669
101A	15x16	Gilead loamy sand	80 (77)	9 11 15 16	56.50	181	83 (7/) (7/) 83	5.9 2/ 6.5 2/ 7.8 9.0	40 -- 65 68	29 -- 49 52	0.75 1.03 1.15 1.36	5/ 31.892 44.640 64.838 63.052
163B	15x16	Gilead loamy sand	80 (72)	9 15	12.35		87 85	5.2 8.2	38 55	27 46	0.65 1.30	29.948 5/ 67.579
124A	16x16	Lakeland and Gilead loamy sands	76 80 (75)	8 14 15	25.69	170	81 81 81	5.0 8.3 8.6	36 59 63	26 46 49	0.50 1.26 8/ 1.23	5/ 23.447 61.304 63.243
155I	16x16	Gilead loamy sand	80 (71)	8 15	4.90		88 86	5.1 8.7	30 54	23 45	0.46 1.33	21.961 68.070
155J	16x16	Gilead and Susquehanna loamy sands	80 69 (70)	8 15	8.80		80 70	4.0 8.4	28 58	19 43	0.32 1.00	17.413 52.481
163C	16x17	Lakeland and Gilead loamy sands	76 80 (69)	9 15	22.67	160	87 86	5.2 8.4	36 51	26 43	0.48 1.13	5/ 23.384 58.045
167A	16x17	Gilead loamy sand	80 (64)	9 15	25.54		68 65	4.0 7.9	28 49	18 39	8/ 0.36 0.77	5/ 18.01 40.937
220A	17x17	Lakeland and Gilead loamy sands	76 80 (78)	8 15	14.89	151	(7/) (7/)	2/ 5.5 2/ 6.8	40 59	31 49	0.79 1.46	30.549 77.152

1/ Includes planted trees only, except where noted.
2/ Includes planted trees and wildlings.
3/ Survival cannot be determined because only trees 0.6 inch and over were tallied.
4/ The figure without parentheses represents the average site index of natural slash pine stands growing on the same soils on the experimental forest. The figure in parentheses is the projected height of the planted trees at 25 years of age as read from Barnes and Ralston's site quality curves in "Soil Factors Related to Growth and Yield of Slash Pine Plantations," Fla. Agr. Expt. Sta. Bul. 559, 1955. Where a plantation area is made up of two soil types, the site index of each type is given.
5/ Plantation suffered one or more severe burns.
6/ Numerous merchantable wildlings bolstered yield despite poor survival of planted stock.
7/ Survival data unavailable.
8/ Several merchantable wildlings cut between inventories.

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